Comparison of White Crappie Populations in Diked and Undiked Lake Erie Wetlands[1]

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ABSTRACT. Most of Ohio's remaining Lake Erie wetlands are diked to enhance habitat diversity. There is concern that fish communities in these wetlands may be isolated from adjacent waters. However, little data are available with which to evaluate possible isolation. We conducted a study that examined spring length frequencies, age structure, and growth of white crappie (*Pomoxis annularis*) populations in 3 diked wetlands and 2 undiked, adjacent areas. If populations are not isolated then differences in population parameters between the two types of systems should not be evident. White crappies were collected in April-May 1987 using trap nets. Length frequencies of white crappies were not similar between diked wetlands and adjacent areas, and mean lengths were significantly less in the diked wetlands. Populations were not comprised of similar age classes in the 5 systems. White crappies in diked wetlands grew significantly slower than their conspecifics in the undiked areas. These data indicate that white crappies in diked wetlands are isolated from populations in undiked areas even though up to 75% of water in diked wetlands can be exchanged each year.

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INTRODUCTION

Wetlands and their diverse macrophyte communities provide important habitats for a variety of fish species (Liston and Chubb 1985, Johnson 1989). Extensive agricultural, commercial, and industrial pressures have reduced these coastal wetlands along the western basin of Lake Erie from about 4,000 km^2 to about 100 km^2 (Herdendorf 1987). Most (84%) of the remaining 100 km^2 has been diked by both private and governmental entities so that water level manipulations can create enhanced wildlife habitats (Bookhout and others 1989). The few remaining undiked areas provide little in the way of quality habitat as the effects of carp, wind, water level fluctuations, and agriculture have combined to create very turbid systems containing little or no vegetation.

Regulatory agencies have become concerned about the impact of diking on fish communities. Of special concern is whether the dikes are restricting fish movement into and out of wetlands containing most of the remaining quality wetland habitat in western Lake Erie. Johnson and others (1997), in a study of a diked wetland and its adjacent undiked area prior to ours, concluded that the fish community in the diked wetland appeared to be isolated. Catch rates, sizes collected, and body condition of species common to both areas were significantly different between these areas. Subpopulations of a fish species can result when part of a population becomes spatially separated from the remainder of that population. If isolation is of sufficient duration, these subpopulations may begin to show differences in population parameters such as age structure, growth rates, and condition (Everhart and others 1975).

In this paper, we present length frequencies, age structures, and growth rate data of white crappie (*Pomoxis annularis*) collected from 3 diked wetlands and 2 adjacent undiked areas of Lake Erie. Comparison of these parameters will allow us to evaluate if populations of white crappie in diked wetlands are likely isolated from adjacent undiked areas with respect to population form. In addition, these data will provide additional insight into the impacts of diking and management strategies on fish communities.

MATERIAL AND METHODS

Study Areas

White crappie were collected from 3 diked wetlands, two of which were located in western Sandusky Bay with the remaining diked wetland being adjacent to Lake Erie. Muddy Creek Bay and Crane Creek were the undiked areas sampled along Sandusky Bay and Lake Erie, respectively. Rusk #2 (hereafter Rusk) was an 18 ha privately-owned diked wetland on the north shore of Sandusky Bay and receives its water via a township canal connected to Sandusky Bay. Boardman's Unit (hereafter OSC) was a 40 ha diked wetland within the Ottawa Shooting Club on the south side of Muddy Creek Bay. Its water source was Muddy Creek Bay. The remaining diked wetland sampled was pool 2b (hereafter ONWR) on the Ottawa National Wildlife Refuge, a 38 ha wetland receiving its water from Crane Creek near its confluence with Lake Erie. All 3 wetlands contained diverse macrophyte communities. Muddy Creek Bay and the Crane Creek Embayment are large shallow, undiked areas (>100 ha) characterized by turbid water and little vegetation.

Fish Collection

Juvenile and adult white crappie were collected from 10 April through 17 May 1987. Spring sampling was done to insure that yearly growth annuli had not yet been laid down. Five South Dakota style trap nets (1.5 m square, 30-m leads, 13 mm mesh) were fished about

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21 h per day for 2-4 d at each of the 5 areas. Trap net locations within each study area were randomly selected at the beginning of each sampling period. White crappies collected were measured to the nearest millimeter (TL, total length). For each area, a subsample of 5 white crappie per 10 mm length group (range 50-350+ mm TL) were frozen for later growth work.

Length Frequencies

Length frequencies (25 mm groups) were constructed and Kolmogorov-Smirnov's (K-S) test (Hollander and Wolfe 1973) was used to determine if white crappie length distributions were different between diked and undiked areas within the Sandusky Bay or Lake Erie watersheds. A proportional stock density (PSD) was calculated for each wetland. PSD is a numerical descriptor of length frequency data and can provide insight into population structure and dynamics (Anderson and Neumann 1996). PSDs were calculated as follows:

$$PSD = (\# \text{ of fish } >200 \text{ mm} / \# \text{ of fish } \geq 130 \text{ mm}) * 100$$

Age and Growth

We chose to use otoliths for determining age and growth rather than scales because of greater accuracy associated with otoliths (Boxrucker 1986). The assumption that otolith radius is proportional to total fish length has been validated (Boxrucker 1986, Schramm and Doerzbacher 1982). Otoliths were removed and placed in glycerine for 1-2 weeks to clear and then examined using methods described by Schramm and Doerzbacher (1982). Each otolith was examined by 2 individuals and the age of the fish was accepted once both individuals agreed. If agreement could not be reached, the otolith was discarded from the data set. Length-at-age (growth) for each fish was calculated as follows:

$$Li = (ABi / OR) * TL$$

where Li = length at age i, ABi = distance to the annual band associated with age i, OR = otolith radius, and TL = total fish length. From these data, mean lengths-at-age were calculated for each age class at each of the 5 sample areas. Analysis of variance (ANOVA) was used to statistically compare these means between areas within a watershed. Age frequencies were constructed and Kolmogorov-Smirnov's (K-S) test was used to determine if white crappie age distributions were different between diked and undiked areas.

RESULTS

A total of 1031 trap-net hours resulted in a catch of 239 white crappies, all areas combined. Catches per 24-h period in Muddy Creek Bay and the Crane Creek Embayment were 7.6 and 3.4 fish, respectively. Catches in OSC, ONWR, and Rusk wetlands were 3.8, 4.8, and 11.0 fish per 24 h, respectively.

Length Frequencies

Length frequencies of white crappies varied considerably among the 5 areas sampled (Fig. 1). Within both the Sandusky Bay and Lake Erie watersheds, length distributions were dissimilar between the diked wetlands and the adjacent undiked area (K-S test, $P < 0.05$). PSDs for the 2 undiked areas (100 & 96) exceeded values from the diked areas in both watersheds. Catches in undiked areas were composed largely of adult white crappie (>225 mm) whereas catches in diked wetlands contained juveniles and adults with the exception of Rusk (Fig. 1).

Age and Growth

Age distributions of white crappies varied considerably among the 5 areas (Fig. 2). Within both watersheds, age distributions were dissimilar between the diked wetlands and the adjacent undiked area (K-S test, $P < 0.05$).

Average length-at-age (all year classes combined) was less in diked wetlands than in the adjacent undiked areas for both the Sandusky Bay and Lake Erie areas (Fig. 3). Comparisons of length-at-age for the age classes (2-4) common to the systems indicated that white crappie growth was significantly less in the diked wetlands as compared to undiked areas (Table 1, ANOVA, $P < 0.05$). In undiked areas, white crappie grew quickly to 270 and 297 mm TL on average in Crane Creek and Muddy Creek Bay by age 4. Length-at-age varied considerably among the diked wetlands at all ages with Rusk on Sandusky Bay exhibiting very slow white crappie growth while OSC exhibited the fastest growth. Four year old fish averaged 187 mm TL in Rusk and 261 mm TL in OSC.

DISCUSSION

Johnson and others (1997) provided the first evidence that fish communities in diked wetlands may be biologically isolated from communities in adjacent undiked areas. Their working premise was that considerable exchange of fish or similar conditions within diked and undiked areas would create similar population parameters for each species. However, they found that mean lengths of 5 fish species common to both a diked and undiked area were significantly smaller in the diked wetland. Body condition factors of white crappie and brown bullhead were also lower for populations in the diked wetland. These data suggest that fish communities in their diked wetland were probably isolated from adjacent Muddy Creek Bay. They also noted that ecological conditions between the two areas are different and can cause biological isolation even though fish exchange may occur. Johnson and others (1997) noted that growth information was needed and additional wetlands needed to be sampled before it can be conclusively decided that diked wetland fish communities are isolated.

Our study of white crappie provides additional evidence that fish communities in diked wetland may be biologically isolated. In both the Lake Erie and Sandusky Bay watersheds, we found that spring length frequencies of white crappie were significantly different with smaller fish predominating in the diked wetlands. Johnson and others (1997) noted similar findings for white crappies and hypothesized that growth was slower in the diked wetlands. Our data indicate their hypothesis was likely

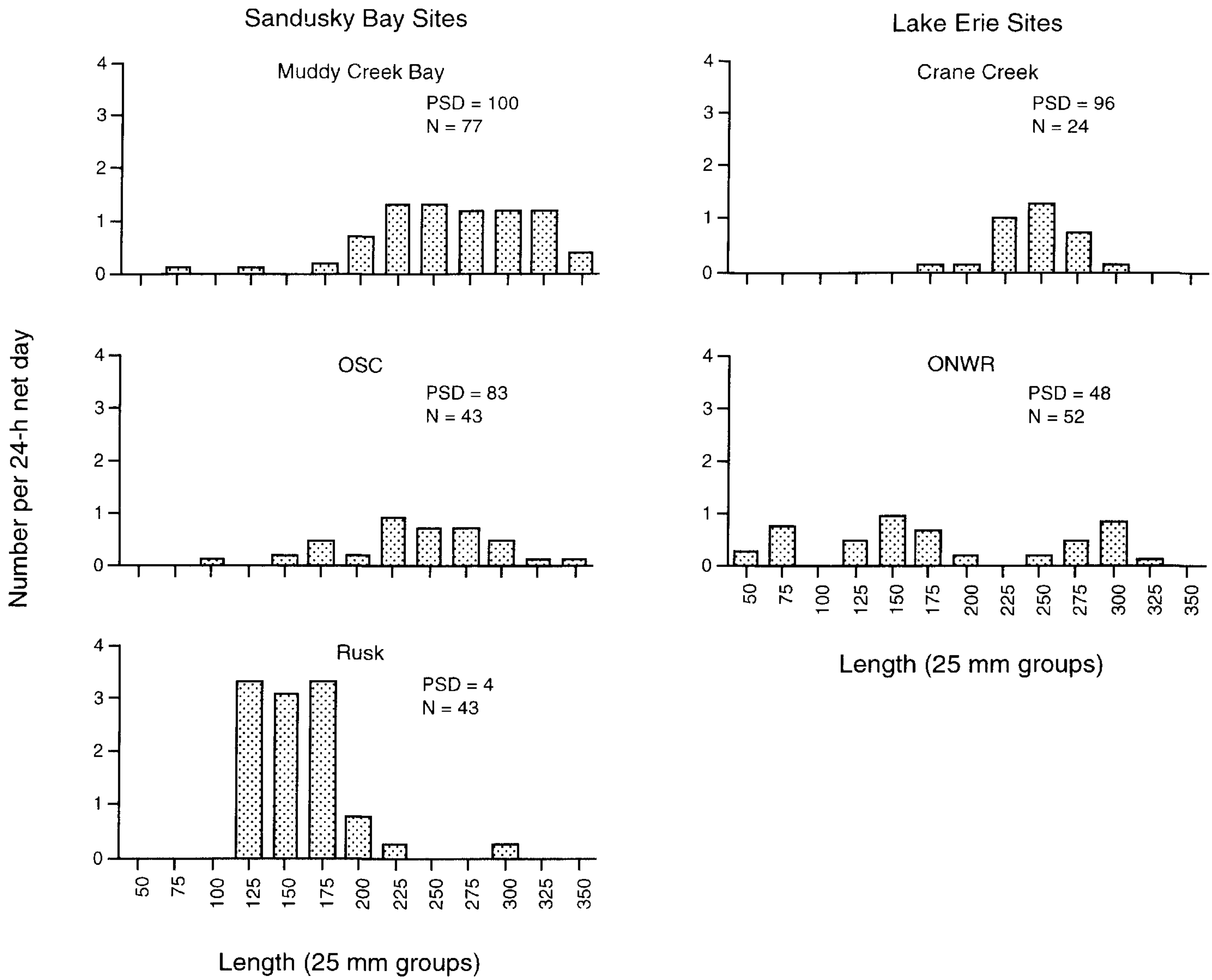

FIGURE 1. Length frequencies (number per 24-h net day) of white crappies collected from Sandusky Bay and Lake Erie sites. Undiked sites were Muddy Creek Bay and Crane Creek, diked wetlands included OSC (Ottawa Shooting Club), Rusk (Rusk Marshland), and ONWR (Ottawa National Wildlife Refuge). N = total number collected during the 2-4 d sampling period in each wetland. Proportional Stock Density (PSD) is the proportion of fish exceeding 130 mm total length that also exceeded 200 mm total length.

correct. Not only was white crappie age structure different between systems, but growth was significantly less in the diked wetlands. Apparently white crappie populations in diked wetlands can be considered biologically isolated, and we suspect this situation exists for other fish species as well.

Isolation of fish communities in diked wetlands might be expected given that earthen dikes and water control devices create considerable barriers to fish movement into and out of these wetlands. However, the need to remove water in spring and add it in fall may result in a water exchange of up to 75% each year and could provide ample opportunity for fish exchange between diked and undiked areas. We have sampled (unpublished data) the culvert pipe connecting the diked wetland investigated by Johnson and others (1997) to adjacent areas and found white crappies moved both directions during the spring. However, total numbers leaving were small compared to the white crappie population within the diked wetland and was not extensive enough to prevent Johnson and others (1997) from finding significant differences between the diked wetland and Muddy Creek Bay populations.

Absence of extensive fish exchange between diked wetlands and adjacent undiked areas indicates physical isolation, but we also suspect that differences in ecological conditions between the areas may cause the growth differences we observed. We have unpublished data over several years that suggests larval fish densities in Johnson and others' (1997) study wetland were several orders of magnitude less than in Muddy Creek Bay. White crappie are piscivorous predators when prey fish are available and have been shown to rapidly increase body condition and growth in response to abundant prey (Gabelhouse 1991). This likely accounts for fast growth in undiked areas. Additionally, fish production

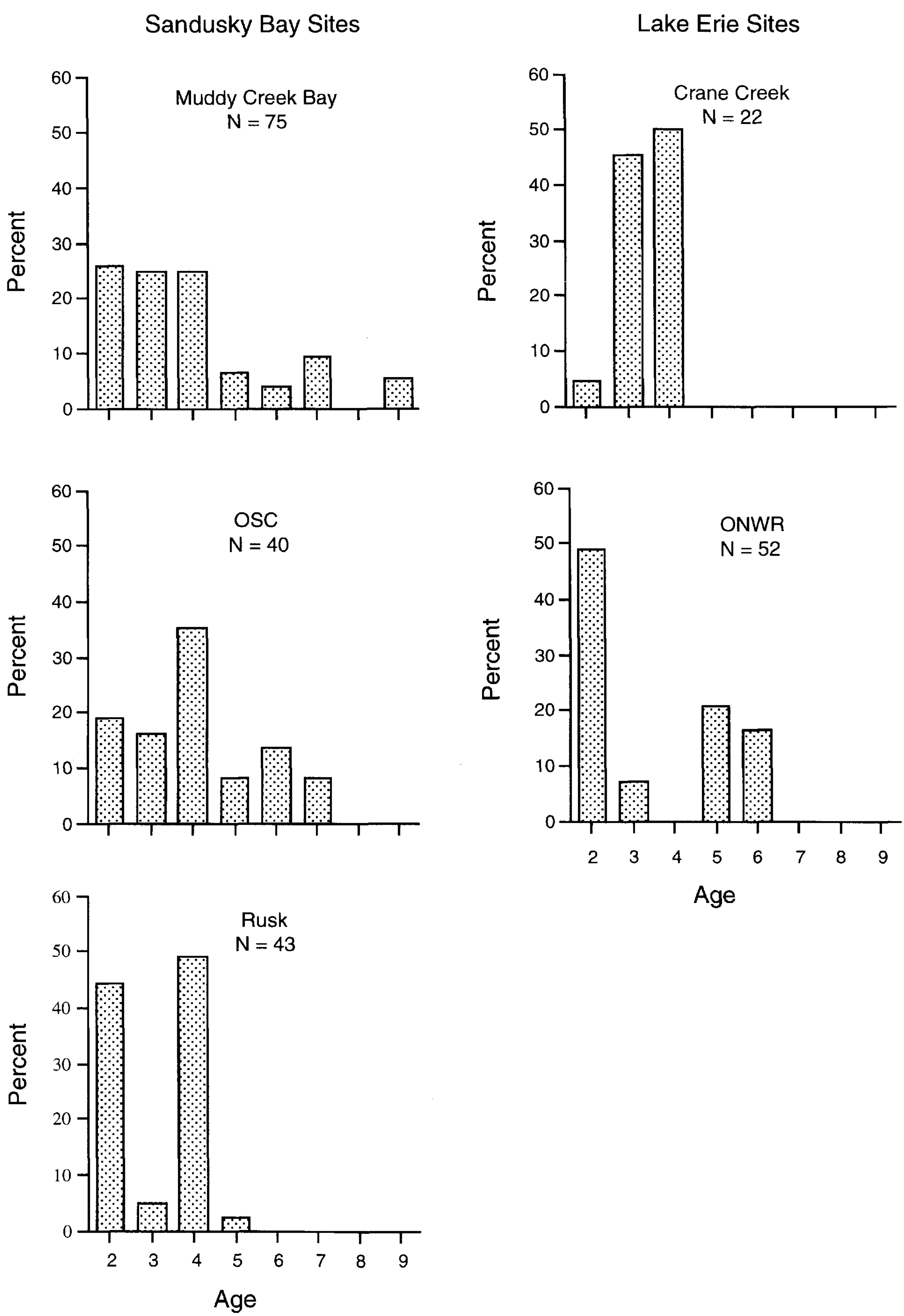

FIGURE 2. Age distributions of white crappies collected from Sandusky Bay and Lake Erie sites. Undiked sites were Muddy Creek Bay and Crane Creek, diked wetlands included OSC (Ottawa Shooting Club), Rusk (Rusk Marshland), and ONWR (Ottawa National Wildlife Refuge). N = number of fish that were aged and does not necessarily equal total number collected.

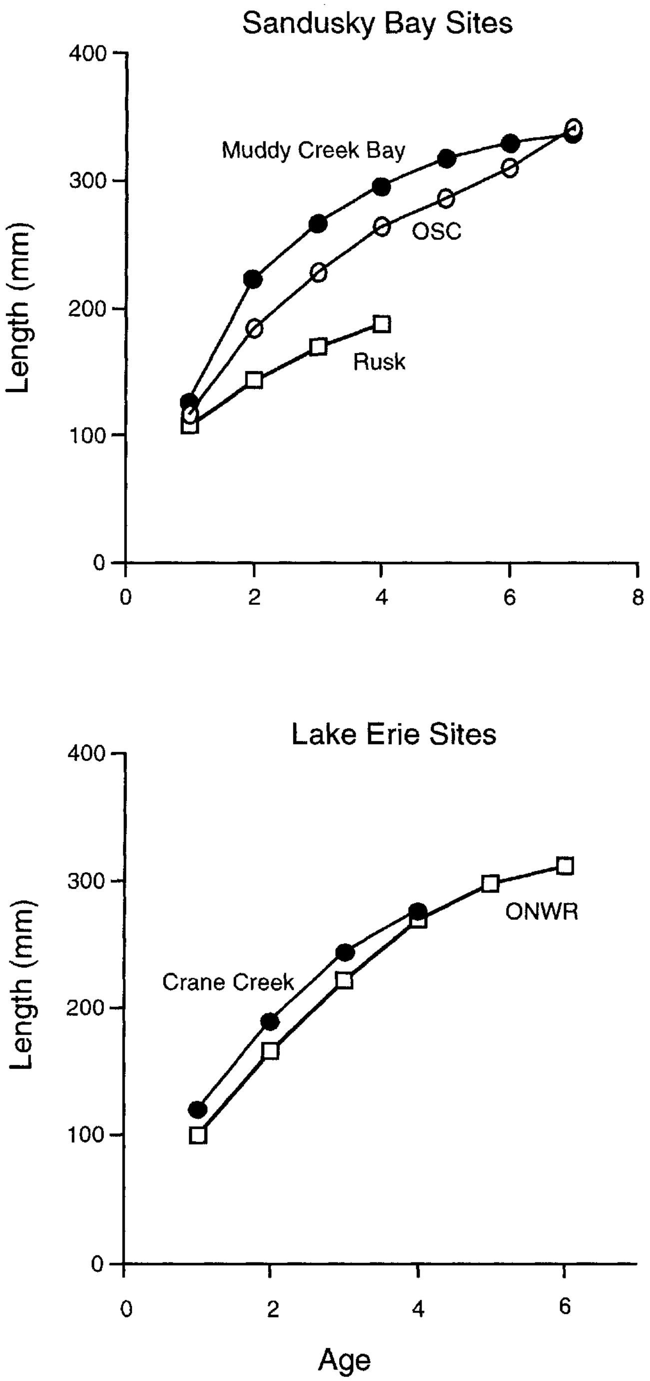

FIGURE 3. Mean backcalculated length-at-age (all year classes combined) of white crappies collected from Sandusky Bay and Lake Erie sites. Undiked sites were Muddy Creek Bay and Crane Creek, diked wetlands included OSC (Ottawa Shooting Club), Rusk (Rusk Marshland), and ONWR (Ottawa National Wildlife Refuge).

may well be limited in diked wetlands by reduced nutrient inputs (Sager and others 1985, Robb and Mitsch 1992), low oxygen and increased water temperatures during summer drawdown (Navarro and Johnson 1992), and the extensive vegetated areas within tying up nutrients. It is our belief that ecological conditions are very different in diked wetlands as compared to adjacent waters and may very well create biologically different fish populations and communities.

White crappie populations in the 3 diked wetlands sampled exhibited considerable differences in the parameters we examined. Rusk and ONWR had white crappie populations that grew significantly slower than the population in OSC. The two former wetlands differed from the latter in two respects; they both 1) contained populations of largemouth bass (*Micropterus salmoides*) and northern pike (*Esox lucius*) whereas the Boardman Unit did not, and 2) undergo less spring drawdown and thus, have higher summer water levels. Adult white crappie must compete for limited prey fish with these two predator species which may limit white crappie growth in Rusk and ONWR. Additionally, carp (*Cyprinus carpio*) densities in these two wetlands were low (0.2 and 0.5 fish per net day during this study), creating clear water and considerable submerged vegetation. White crappie are considered to be a pelagic species and prefers less vegetated areas (Trautman 1981). Therefore, white crappie probably cannot be expected to grow well in vegetated systems.

An often debated subject in Ohio's Lake Erie region relates to management of fish communities in diked wetlands. There are proponents of opening the dikes to enhance fish exchange and allow fish access to possible spawning areas. We presently do not advocate this strategy. We are concerned that "breached" dikes may substantially reduce the present vegetated habitats in diked wetlands crucial to the management of wildlife species, some of which are threatened or endangered. As noted by Johnson and others (1997), research is needed to assess impacts on flora and fauna by allowing continual water exchange. We encourage efforts on improving fish communities in the diked wetlands, focusing on activities such as stocking predators to control carp populations and providing deep water areas for fish communities to use during periods of temperature extremes and low oxygen in shallow areas.

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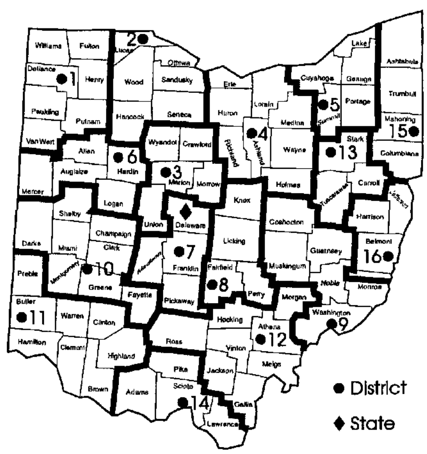

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